



# **Validation of MLS BrO**

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# MLS BrO

## MLS BrO signal is weak

S/N = 0.05

## Three retrieval products developed so far

### 1. V 1.5

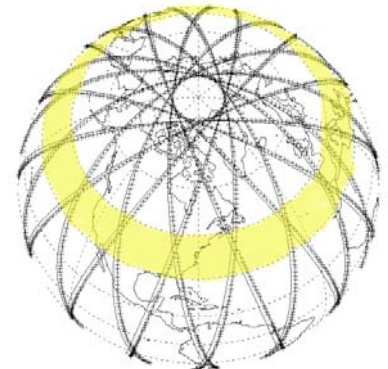
- Problems
  - Large oscillations with altitude
  - Large biases at low altitude
- Poor tradeoff between precision and vertical resolution
- Not useful for scientific studies

### 2. Interim version: BinRad

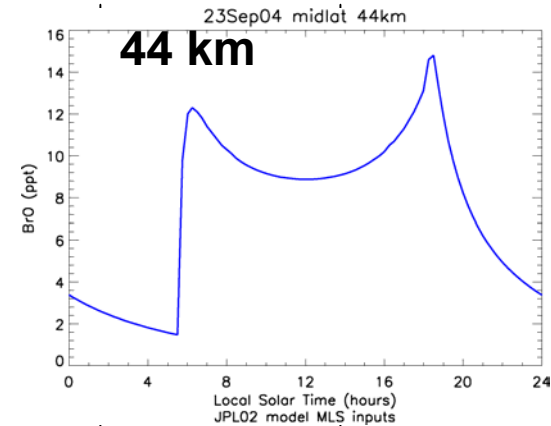
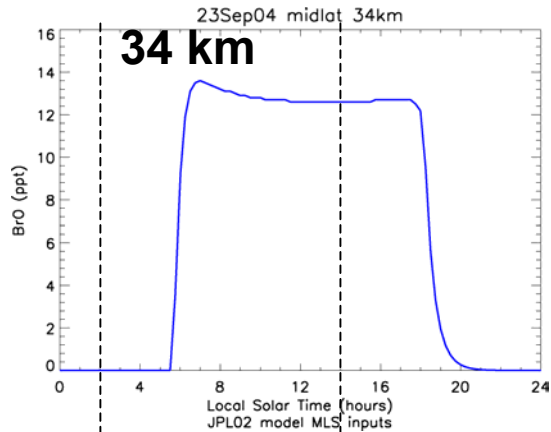
- Zonal mean average of radiances
- Better tradeoff between precision and vertical resolution
- Successfully used in scientific study

### 3. V 2.1

- Only a few days available
- So far looks better than V 1.5 but not as good as BinRad



# Minimizing biases in MLS BrO Signal



descending

ascending

- Models predict a large diurnal variation for BrO
  - For altitudes up to about 4.6 hPa (38 km), nighttime BrO is negligible
- Therefore we approximate daytime BrO as the day/night difference

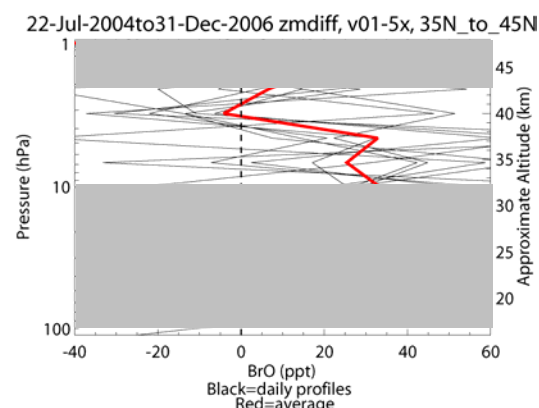
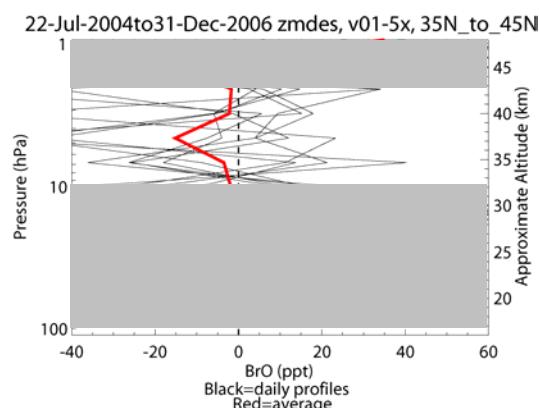
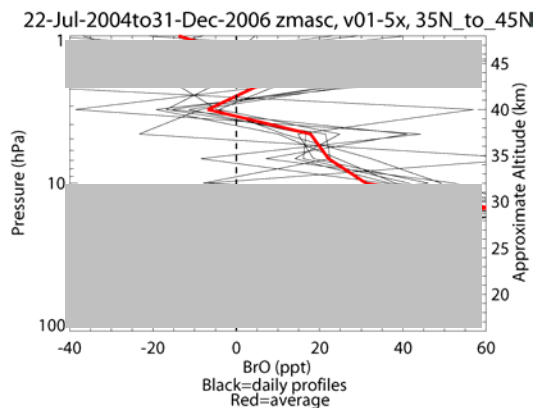
# Three Versions of MLS BrO

Day

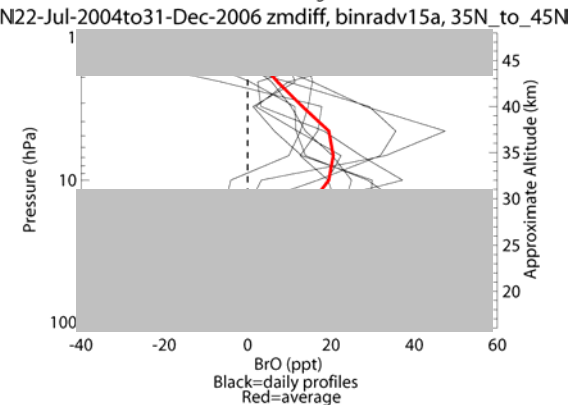
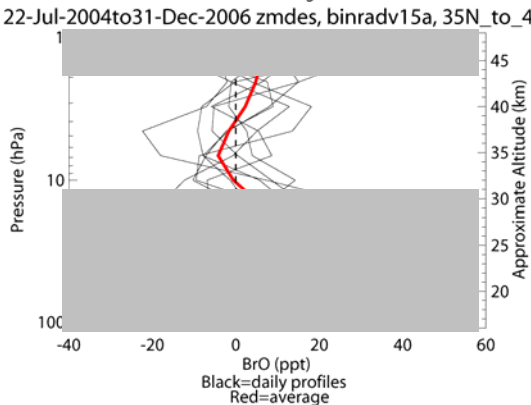
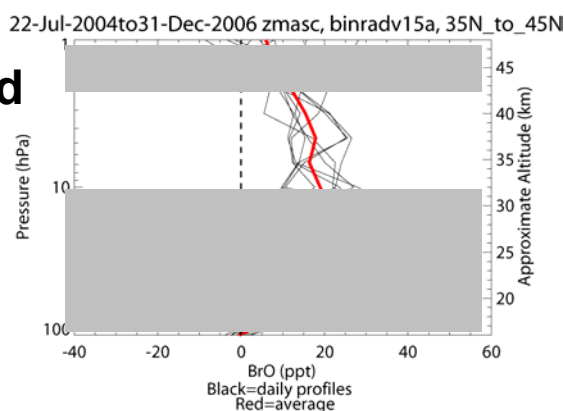
Night

Difference

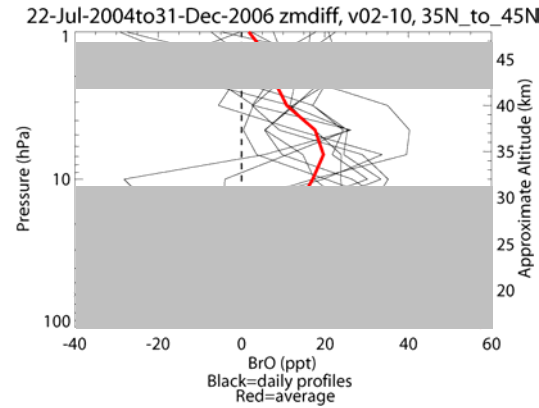
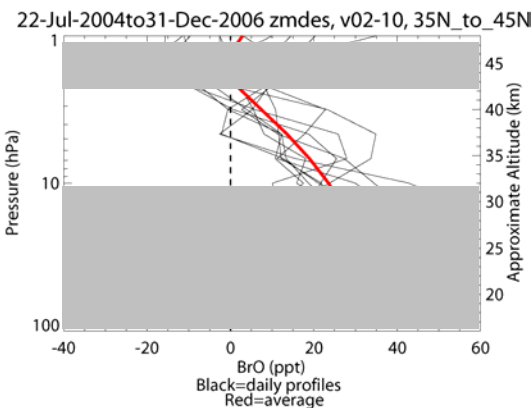
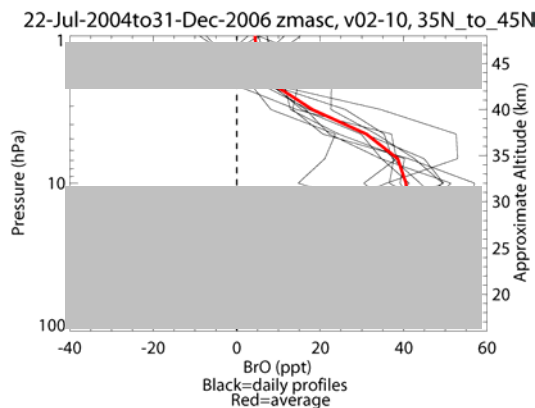
V1.51



VBinRad



V2.1



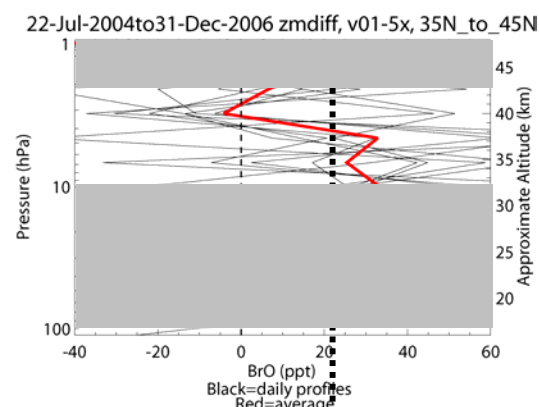
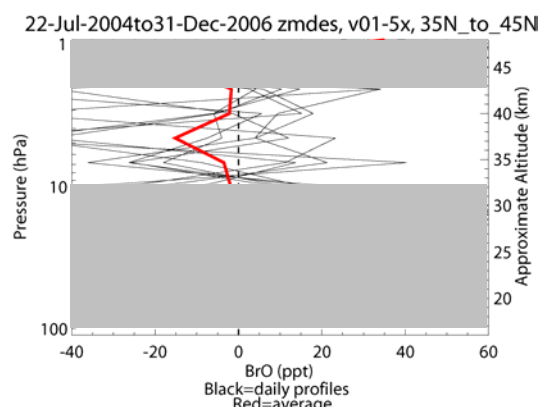
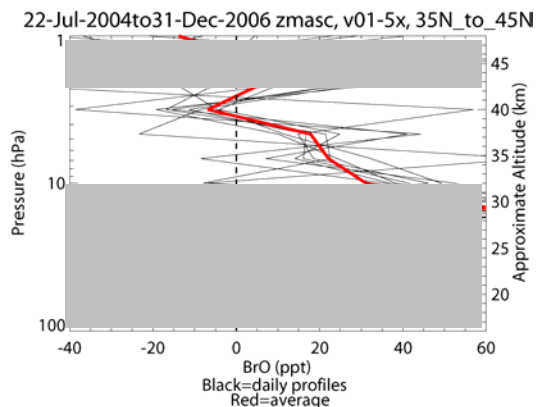
# Three Versions of MLS BrO

**Day**

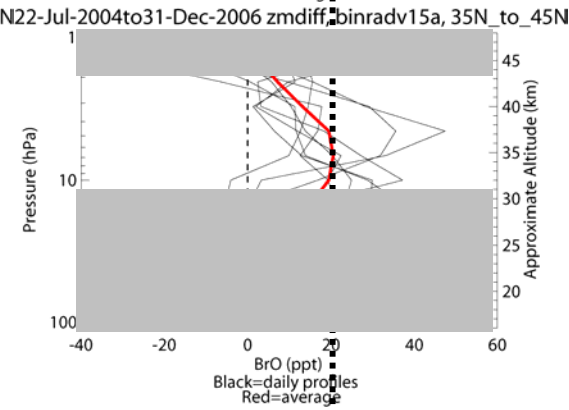
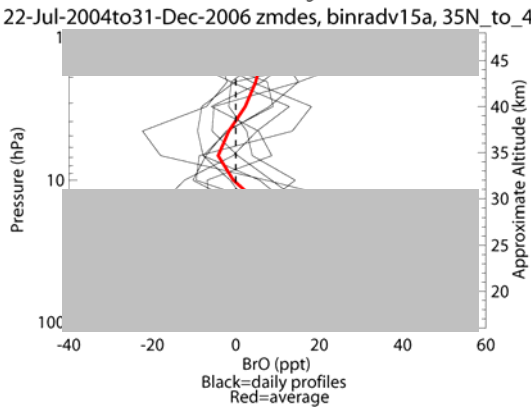
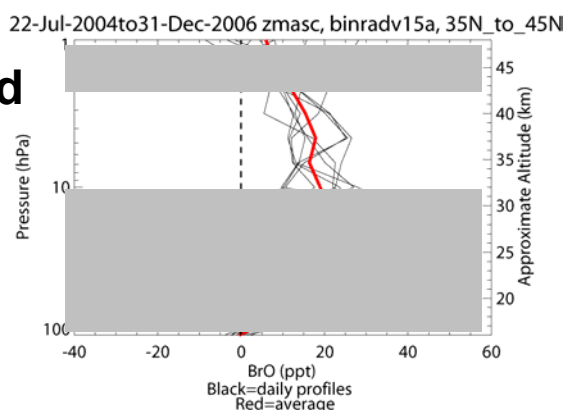
**Night**

**Difference**

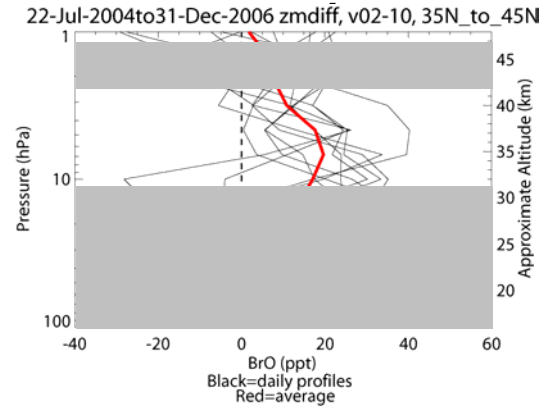
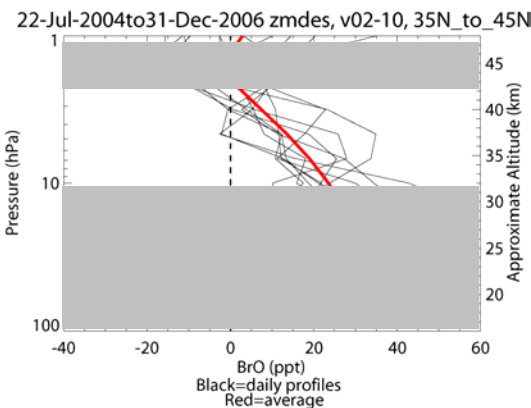
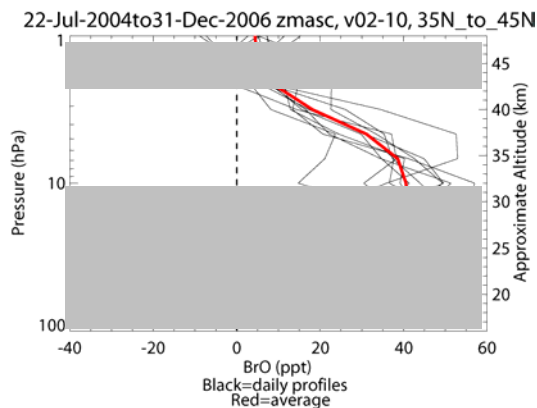
**V1.51**



**VBinRad**



**V2.1**



# Validation of MLS BrO

## 1. Balloon-borne DOAS

- One successful flight since MLS launch: June 17, 2005
- *Data not yet publicly available*

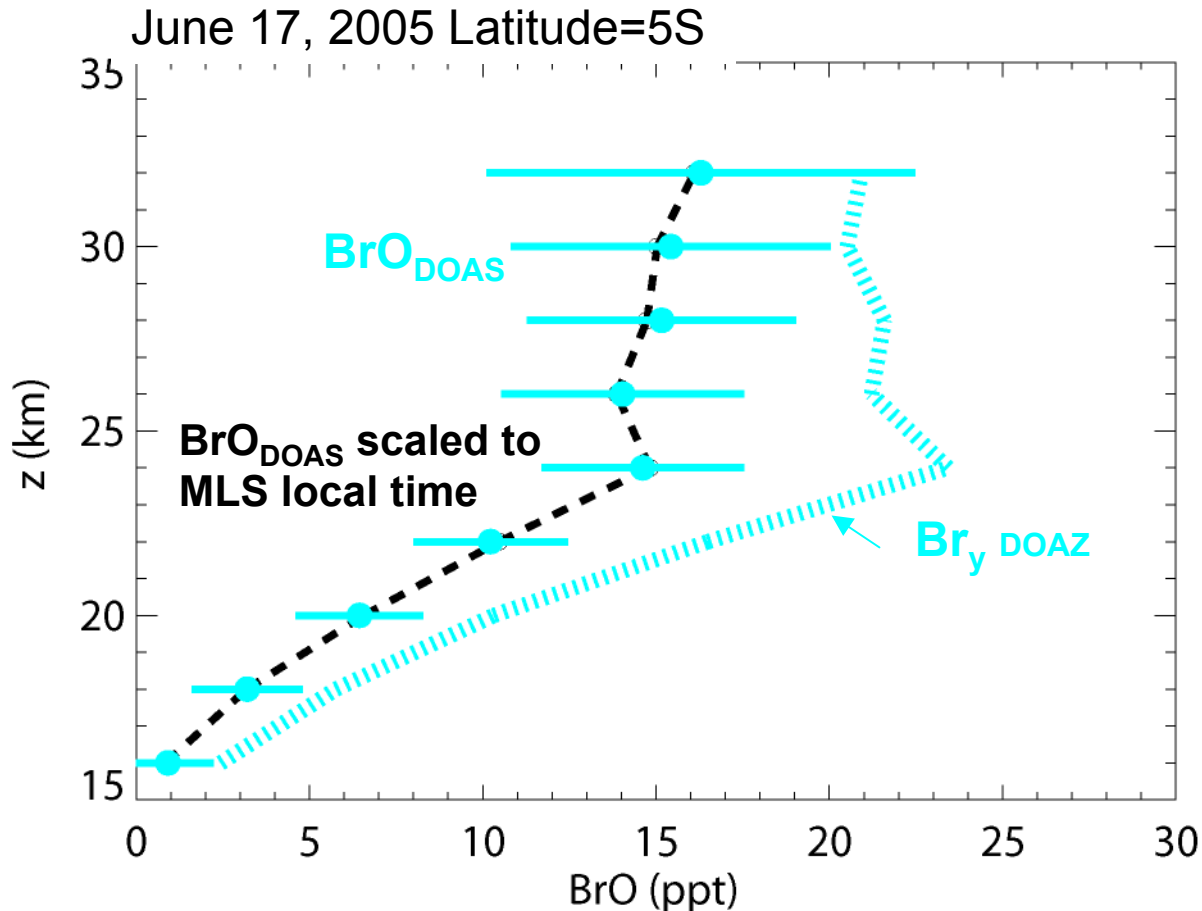
## 2. Balloon-borne SAOZ

- One successful flights since MLS launch: August 24
- *Data not yet publicly available*

## 3. Satellite-borne SCIAMACHY

- Has been collecting data since 2002
- *The results from two retrieval groups are inconsistent; thus we do not consider here*

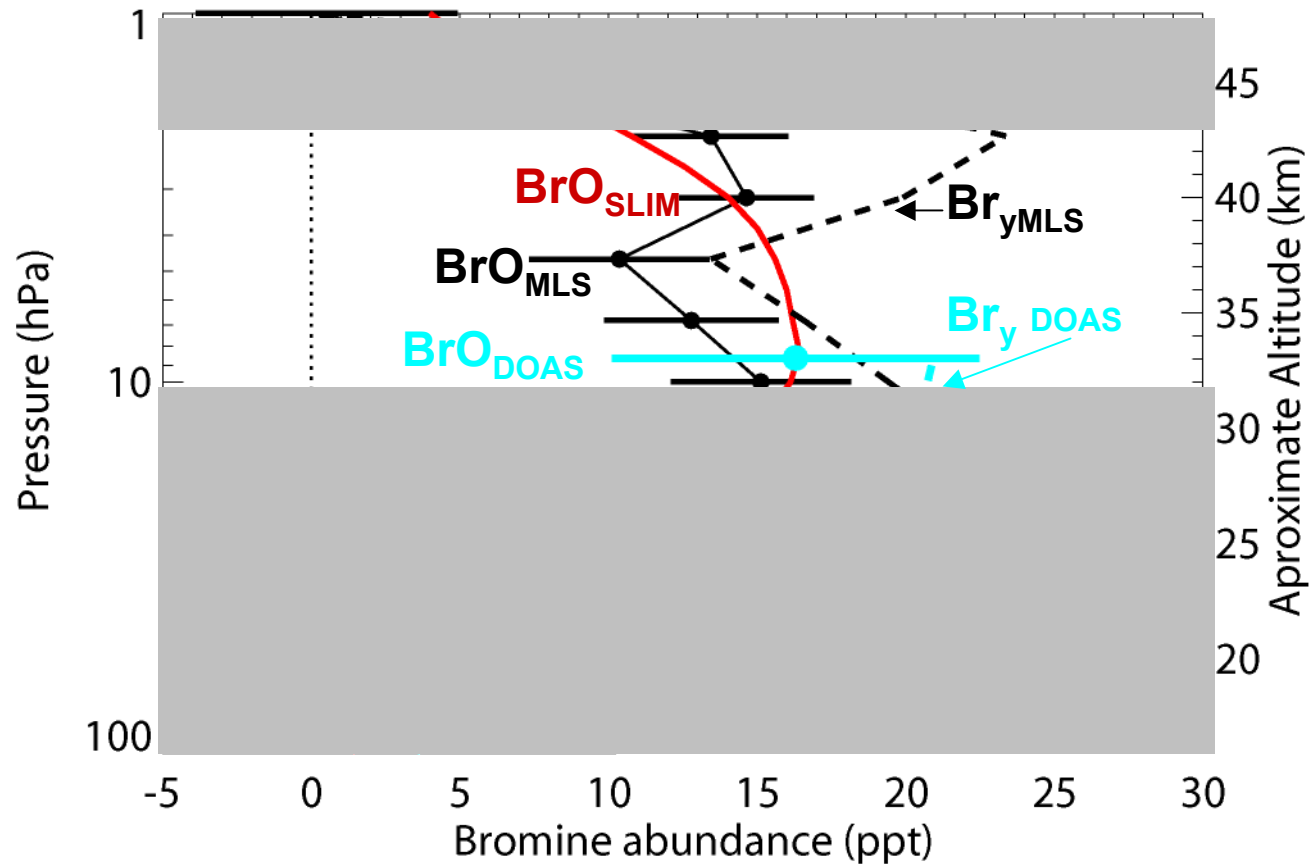
# Preliminary DOAS data



- Difference in local time between DOAS and MLS measurements has negligible effect on BrO
- Inferred  $\text{Br}_y \sim 21.5 \pm 6 \text{ ppt}$ 
  - in agreement with DOAS team estimate of  $21.5 \pm 2.8 \text{ ppt}$ , with  $\text{Br}_y^{\text{trop}} = 3.5 \text{ to } 5 \text{ ppt}$
  - Recall  $\text{Br}_y$  inferred from MLS BrO:  $18.6 \pm 5.5 \text{ ppt}$

# Compare MLS data with preliminary DOAS data

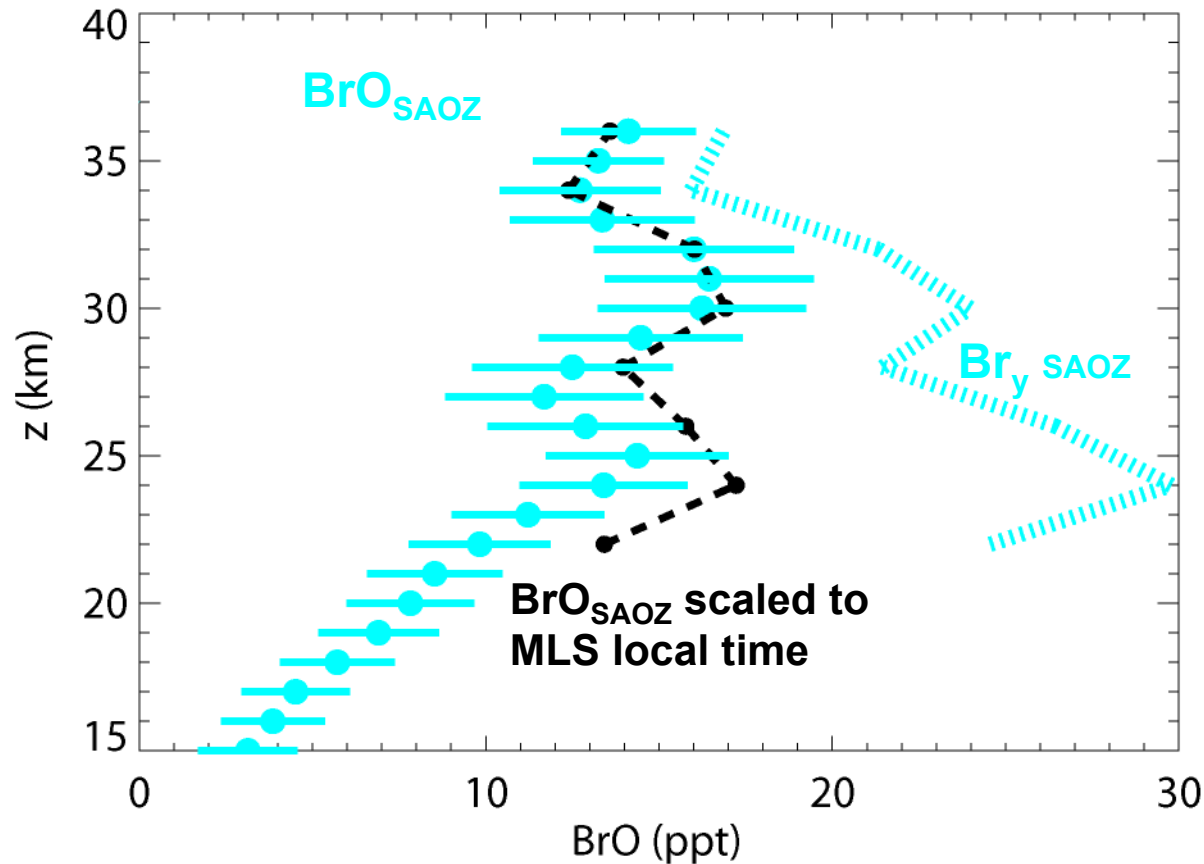
DOAS flight June 17, 2005 Latitude=5S



- MLS monthly zonal mean for 5S to 5N
- MLS and DOAS  $\text{BrO}$  and  $\text{Br}_y$  agree within uncertainty

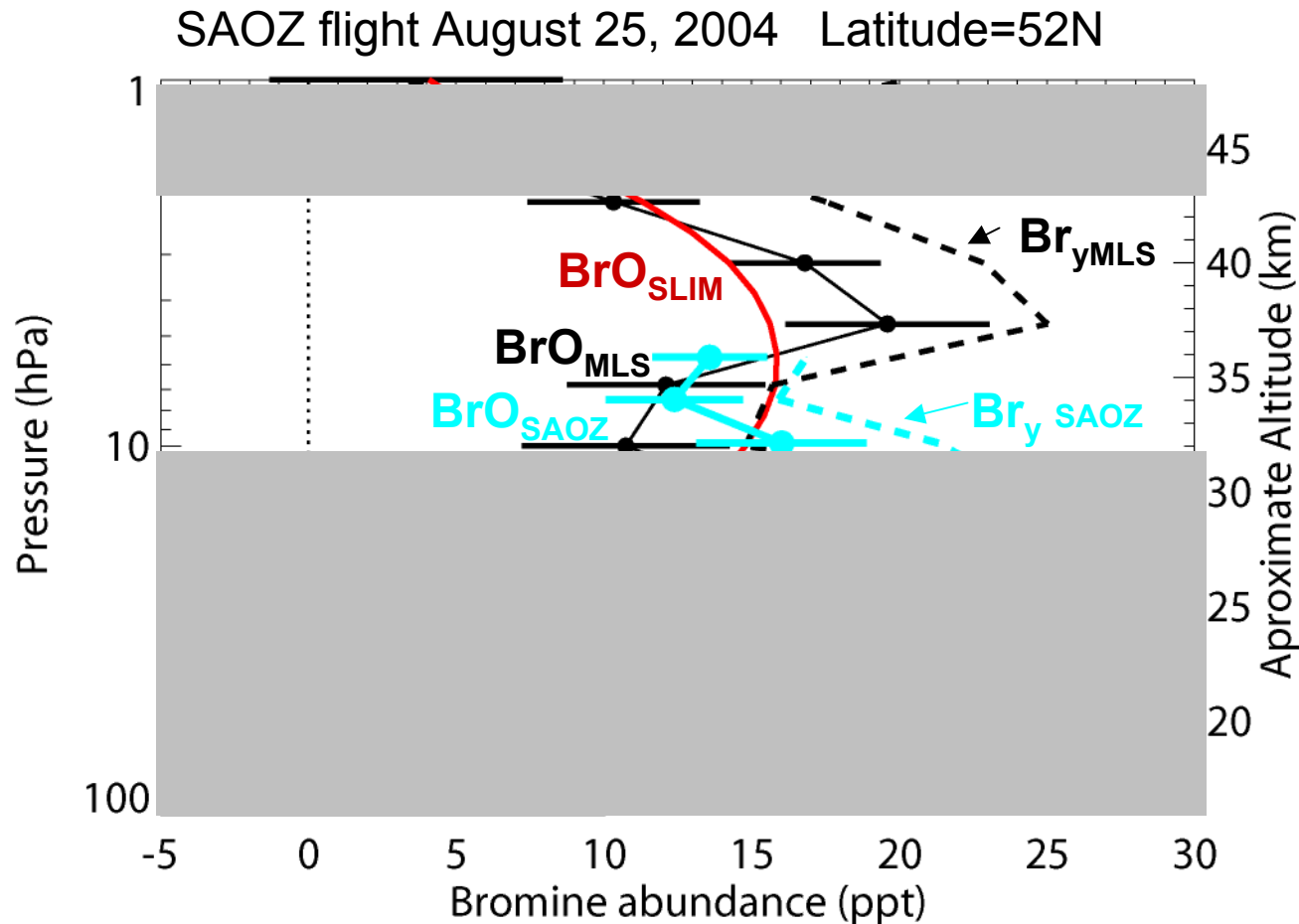
# Preliminary SAOZ data

SAOZ flight August 25, 2004 Latitude=52N



- Difference in local time between SAOZ and MLS measurements has an effect on BrO
- Inferred Br<sub>y</sub> ~ 16 - 30 ppt
  - Recall Br<sub>y</sub> inferred from MLS BrO: 18.6 ppt

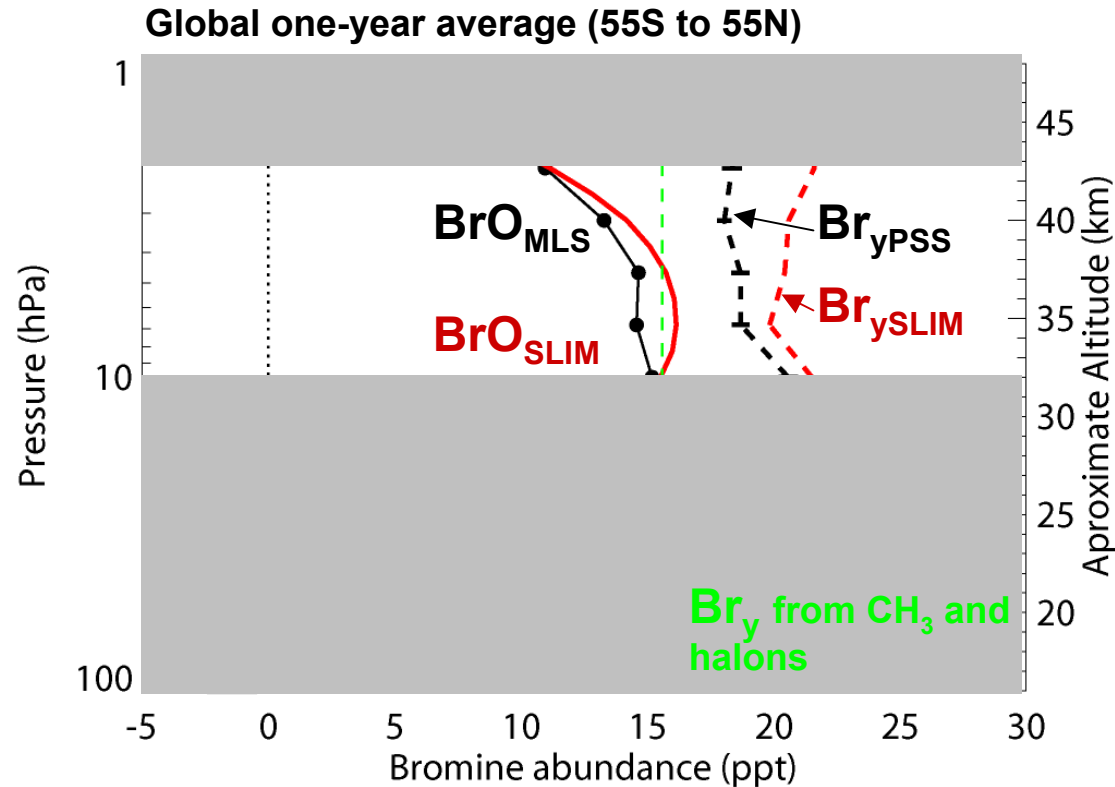
# Compare MLS data with preliminary SAOZ data



- MLS monthly zonal mean for September 2004 45N to 55N
- MLS and SAOZ BrO agree within uncertainty

# Inferring Br<sub>y</sub> from MLS BrO (BinRad Version) using models

Livesey et al., GRL (in press)



- **Two methods**
  - **SLIMCAT**
$$[\text{Br}_y]_{\text{MLS}} = \text{BrO}_{\text{MLS}} \times \frac{[\text{Br}_y/\text{BrO}]_{\text{Slimcat}}}{[\text{Br}_y/\text{BrO}]_{\text{SLIMCAT}}}$$
  - **Photochemical Steady State Box Model (PSS)**
    - Model constrained to MLS measurements of BrO, O<sub>3</sub>, H<sub>2</sub>O, and N<sub>2</sub>O
- **Resulting Br<sub>y</sub>:** (JPL02 kinetics with BrONO<sub>2</sub>+O reaction)
  - Br<sub>y</sub> SLIMCAT = 20.7 ppt
  - Br<sub>y</sub> = 18.6 ± 5.5 ppt
- **Advantage of PSS model**
  - O<sub>3</sub> and NO<sub>2</sub>

# Future Work

- **Version 2.1**
  - Once we have more days we will compare with SLIMCAT, DOAS, and SAOZ, as well as with SCIA (when the two retrievals have converged)
- **OMI BrO Column**
  - Is the contribution of upper stratospheric BrO to total column BrO large enough to make this meaningful?
- **Upper stratosphere improvement**
  - Extend use of day/night differences to higher altitudes using photochemical model to compensate for non-zero nighttime BrO
- **Possible anomaly in polar BrO**
  - MLS measurements show higher BrO than expected - need to look into this